given in the REVIEW for December, 1894. The precipitation for the current month was the greatest on record at: Jupiter, 6.27; Lexington, 5.50; Chicago, 6.76; Springfield, Ill., 8.08; Springfield, Mo., 11.02; Kansas City, 5.12; Miles City, 0.77; Astoria, 17.54. It was the least on record at: Minneapolis, 0.15; Sioux City, 0.02; Pierre, 0.01; Lander, trace.

Details as to *excessive precipitation* are given in Tables XIII and XIV.

The *total monthly snowfall* at each station is given in Table II. Its geographical distribution is shown on Chart No. VI. The southern limit of freezing temperatures and possible snow is shown on this chart by the isotherm of minimum 32°. The isotherm of minimum 40°, namely, the air temperature within the thermometer shelter, is also given on this chart, and shows approximately the southern limit of frost on exposed surfaces.

The depth of snow on the ground at the close of the month is shown on Chart VII.

HAIL.

The following are the dates on which hail fell in the respective States:

Arizona, 17. Arkansas, 20. California, 15, 16, 17. Delaware, 31. Georgia, 29. Illinois, 17. Kansas, 16. Nebraska, 16. South Carolina, 26. Texas, 18, 29. Washington, 12, 20, 21, 23, 27.

SLEET.

The following are the dates on which sleet fell in the respective States:

Alabama, 4, 12, 28, 30. Arkansas, 11, 20, 29, 30. California, 15, 19, 20. Georgia, 10. Idaho, 6, 25, 27. Illinois, 1, 10, 11, 19, 20, 22, 24. Indiana, 2, 11, 16, 21. Iowa, 1, 17 to 20, 24, 25, 28. Kansas, 1, 2, 17, 18, 19, 22, 24. Kentucky, 3, 8, 20, 25, 30. Louisiana, 20, 27, 29, 30. Maryland, 8, 21, 26, 28, 30. Michigan, 1, 12, 16, 17, 19, 23. Minnesota, 10, 16, 17, 21, 28. Mississippi, 20, 27, 29, 30. Missouri, 1, 11, 12, 17 to 20, 24, 25, 29. Montana, 14, 27. Nebraska, 20, 22, 23. Nevada, 17 to 20. New Hampshire, 22. New Jersey, 8. New York, 2, 6, 15, 17, 26, 27, 30, 31. North Carolina, 9, 10, 28, 30, 31. North Dakota, 9, 17, 28. Ohio, 2, 8, 12, 21, 25, 26, 27, 30, 31. Oklahoma, 2, 17, 19, 23. Oregon, 5, 12 to 16, 18 to 24, 27, 28, 29, 31. Pennsylvania, 2, 26, 30, 31. South Carolina, 4, 10, 27, 28, 31. Tennessee, 2, 28, 29, 30. Texas, 23, 25, 29. Utah, 13. Vermont, 26. Virginia, 9, 26, 30. Washington, 2, 5, 13, 15, 18, 19, 20, 22, 23, 26, 27, 29, 31. West Virginia, 26, 30, 31. Wisconsin, 11, 17, 19, 20, 25, 28.

WIND.

The *prevailing winds* for December, 1895, viz, those that were recorded most frequently, are shown in Table I for the regular Weather Bureau stations.

The *resultant winds*, as deduced from the personal observations made at 8 a. m. and 8 p. m., are given in Table IX. These latter resultants are also shown graphically on Chart II, where the small figure attached to each arrow shows the number of hours that this resultant prevailed, on the assumption that each of the morning and evening observations represents one hour's duration of a uniform wind of average velocity. These figures indicate the relative extent to which winds from different directions counterbalanced each other.

HIGH WINDS.

Maximum wind velocities of 50 miles or more per hour were reported at regular stations of the Weather Bureau as follows (maximum velocities are averages for five minutes; extreme velocities are gusts of shorter duration, and are not given in this table):

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Miles				*Miles*	
Block Island, R. I	11	68	ne.	Kittyhawk, N. C.	10	60	n.
Do	13	56	ne.	Do	13	66	n.
Do	14	60	ne.	Lexington, Ky	26	60	sw.
Do	27	55	sw.	Nantucket, Mass	11	51	e.
Do	31	57	sw.	New Haven, Conn	27	55	s.
Boston, Mass	31	50	s.	New York, N. Y	26	70	s.
Buffalo, N. Y	7	50	w.	Do	27	73	w.
Do	22	50	sw.	Do	30	50	se.
Do	31	78	w.	Do	31	72	w.
Cheyenne, Wyo	27	50	w.	Oswego, N. Y	31	50	w.
Chicago, Ill	11	54	ne.	Philadelphia, Pa	26	50	sw.
Denver, Colo	30	60	nw.	Portland, Oreg	31	53	se.
Eastport, Me	5	54	ne.	Pueblo, Colo	30	51	w.
Do	6	50	n.	Rochester, N. Y	31	52	sw.
Do	27	54	se.	Tatoosh Island, Wash	3	52	ne.
Do	31	54	se.	Do	11	50	s.
Fort Canby, Wash	2	52	e.	Do	14	52	sw.
Do	9	66	s.	Do	19	60	sw.
Do	11	60	s.	Do	22	60	s.
Do	14	55	s.	Do	23	69	w.
Do	19	60	s.	Do	25	52	w.
Do	22	60	s.	Do	26	56	s.
Do	23	70	s.	Do	27	52	w.
Do	25	50	s.	Do	31	58	s.
Do	26	56	s.	Williston, N. Dak	27	54	w.
Do	29	60	s.	Do	28	50	nw.
Do	31	72	s.	Do	29	52	nw.
Hatteras, N. C	10	60	n.	Winnemucca, Nev	15	54	sw.
Do	11	52	n.	Do	20	56	sw.
Do	13	56	n.	Do	28	58	nw.
Do	31	56	nw.	Woods Hole, Mass	6	52	nw.
Huron, S. Dak	15	52	se.	Do	27	54	se
Independence, Cal	28	53	n.	Do	31	66	sw.

SUNSHINE AND CLOUDINESS.

The quantity of sunshine, and therefore of heat, received by the atmosphere as a whole is very nearly constant from year to year, but the proportion received by the surface of the earth depends upon the absorption by the atmosphere, and varies largely with the distribution of cloudiness. The sunshine is now recorded automatically at 16 regular stations of the Weather Bureau by its photographic, and at 21 by its thermal effects. At one station records are kept by both methods. The photographic record sheets show the apparent solar time, but the thermometric sheets show seventy-fifth meridian time; for convenience the results are all given in Table XI for each hour of local mean time.

Photographic and thermometric registers give the duration of that intensity of sunshine which suffices to make a record, and, therefore, they generally fail to record for a short time after sunrise and before sunset, because, even in a cloudless sky, the solar rays are then too feeble to affect the self-registers. If, therefore, such records are to be used for determining the amount of cloudiness, they must be supplemented by special observations of the sky near the sun at these times. The duration of clear sky thus specially determined constitutes the so-called twilight correction (more properly a low-sun correction), and when this has been applied, as has been done in preparing Table XI, there results a complete record of clear sky from sunrise to sunset in the neighborhood of the sun. The twilight correction is not needed when the self-registers are used for ascertaining the duration of a special intensity of sunshine, but is necessary when the duration of cloudiness is alone desired, as is usually the case.

The cloudiness is determined by numerous personal observations at all stations during the daytime, and is given in the column of "average cloudiness" in Table I; its complement, or percentage of clear sky, is given in the last column of Table XI.

COMPARISON OF DURATIONS AND AREAS.

The sunshine registers give the *duration* of direct sunshine whence the percentage of duration of possible sunshine is derived; the observer's personal estimates give the percentage of *area* of clear sky. These numbers have been brought

together, side by side, in the following table, from which it appears that, in general, the instrumental record of percentages of duration of sunshine is almost always larger than the observers' personal estimate of percentages of area of clear sky; the average excess for December, 1895, is 4.5 per cent for photographic records, and 4.5 per cent for thermometric records. The details are shown in the following table:

Difference between instrumental and personal observations of sunshine.

Photographic stations.	Instrumental.	Personal.	Difference.	Thermometric stations.	Instrumental.	Personal.	Difference.
Phœnix, Ariz.	88	77	11	New Orleans, La	61	60	1
San Diego, Cal.	88	74	14	Portland, Me	60	46	14
Santa Fe, N. Mex.	82	70	12	Wilmington, N.C.	60	55	5
Denver, Colo	79	60	19	San Francisco, Cal	58	53	5
Dodge City, Kans.	66	62	4	Vicksburg, Miss	57	54	3
Savannah, Ga	63	57	6	Philadelphia, Pa	56	41	15
Galveston, Tex.	56	55	1	Atlanta, Ga.	53	55	— 2
Eastport, Me	48	37	11	Little Rock, Ark	49	41	8
Kansas City, Mo.	45	41	4	Des Moines, Iowa.	48	37	11
Washington, D.C.	44	46	— 2	St. Louis, Mo	48	36	12
Eureka, Cal	38	40	— 2	Boston, Mass	43	37	6
Bismarck, N. Dak	37	48	—11	Rochester, N.Y	43	37	6
Helena, Mont.	34	32	2	New York, N.Y	39	38	1
Cleveland, Ohio	30	30	0	Detroit, Mich.	37	32	5
Salt Lake City, Utah	30	19	11	Baltimore, Md.	36	40	— 4
Portland, Oreg. *	13	20	— 7	Cincinnati, Ohio	33	33	0
				Columbus, Ohio	32	25	7
				Chicago, Ill	28	26	2
				Louisville, Ky	26	24	2
				Buffalo, N.Y.	20	17	3
				Portland, Oreg.*	13	20	— 7

* Records kept by both methods.

ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table X, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

The dates on which reports of thunderstorms for the whole area were most numerous, were: 17th, 80; 18th, 34; 19th, 22; 21st, 20.

Thunderstorm reports were most numerous in: Illinois, 23; Iowa, 22; Missouri, 39; Texas, 26.

Thunderstorms were most frequent in: Texas, eleven days; Louisiana, seven days; Illinois and Oregon, six days; Kansas, Missouri, and Nebraska, five days.

Auroras.—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, from the 1st to the 5th, inclusive, and also the 27th to 31st. On the remaining twenty-one days of this month 79 reports were received, or an average of about 4 per day. The dates on which the number of reports especially exceeded this average were: 7th, 11; 8th, 17; 9th, 10th, and 24th, 8.

The ratio of auroras to observers was a large percentage in: North Dakota, 50; New Hampshire, 29; Maine, 31.

Auroras were reported most frequently in: North Dakota, eleven days; Minnesota and Montana, five days; Maine, Massachusetts, Nebraska, and Wisconsin, four days.

CANADIAN DATA—THUNDERSTORMS AND AURORAS.

No thunderstorms were reported.

Auroras were reported as follows: St. Andrews, 8th; Father Point, 8th, 13th; Quebec, 8th; Montreal, 9th; Winnipeg, 5th; Minnedosa, 8th; Qu'Appelle, 7th, 8th; Medicine Hat, 23d, 24th; Swift Current, 10th, 29th; Edmonton, 11th, 20th; Battleford, 19th.

INLAND NAVIGATION.

The *extreme and average stages of water* in the rivers during the current month are given in Table VII, from which it appears that the only river that attained the danger line during the month was the Arkansas, which was 5.6 feet above on the 26th at Fort Smith, and 0.5 feet above at Little Rock on the 29th. This rise in the Arkansas followed the heavy rains and snows on the 17th, 18th, 19th, and 20th, above alluded to in the chapter on precipitation. The effect of the rain that fell on these dates upon the height of the lower Missouri River was very appreciable. The tributaries of the lower Missouri were generally overflowed, and the stages of water were the highest ever known in December. The Arkansas rose 20.1 at Little Rock within four days after the rainfall, and the Missouri rose sufficient to cause a rise of 23.4 in the Mississippi at St. Louis. The general drainage into the Mississippi below St. Louis caused a rise of 17.3 at Memphis; 21.3 at Helena, Ark., 28.1, at Arkansas City, Ark., 23.5, at Greenville, Miss., 26.4, at Vicksburg, all on the 31st, and the water had already risen 3 feet on that date at New Orleans, La. On the 1st of the month the Mississippi at Vicksburg had stood at 4.6 below the zero gauge, which is the lowest stage recorded at that city during any previous December.

ICE IN RIVERS AND HARBORS.

The chart of depth of snow and thickness of ice published weekly shows that on Monday, December 2, the distribution of ice was as follows:

Missouri River.—Miles City, 3.0; Williston, 13.0; Bismarck, 2.0; Pierre, 5.0; Yankton, 6.0; Sioux City, 4.0.

Red River of the North.—Moorehead, 8.0.

Mississippi River.—St. Paul, 3.0; Dubuque, 3.0.

Lake Superior.—Duluth, 5.0.

Lake Michigan.—Green Bay, 2.0.

Lake Huron.—Alpena, 0.5.

During the following week the thickness of ice generally increased in the Mississippi, Missouri, Hudson, and other northern rivers.

By December 16 ice had increased on the lower Lakes but diminished in the Missouri River. By December 23 ice had generally diminished or disappeared in the lower Lakes aad upper Mississippi, but increased in the upper Missouri. On Monday, December 30, the condition of the ice was as follows:

Missouri River.—Miles City, 10.0; Williston, 19.0; Bismarck, 7.0; Pierre, 10.0; Yankton, 7.0; Sioux City, 8.0; Omaha, 2.0; Kansas City, 2.0; below this the thickness was 0.0.

Red River of the North.—Moorhead, 15.0.

Upper Mississippi.—St. Paul, 5.0; La Crosse, 8.0; Dubuque, 2.0; below this the thickness was 0.0.

Ohio River.—Louisville, 0.0.

Tennessee River.—Nashville, 0.0.

Lake Superior.—Duluth, 15.0; Marquette, 1.0.

Lake Michigan.—Green Bay, 4.0.

Lakes Huron, Erie, and Ontario.—0.0.

In addition to the preceding the following notes are at hand:

Hermann, Mo., heavy floating ice in Missouri River 3d.

Muscatine, Iowa, Mississippi River frozen over on 5th; ice moved out 17th.

Lake Oneida, N. Y., was frozen over December 16, which is considered quite early in the season for this lake to freeze.

METEOROLOGY AND MAGNETISM.

By Prof. FRANK H. BIGELOW.

For a description of the method of constructing the tables and curves of Chart V, see the WEATHER REVIEW for October, 1895, page 371. The numbers in the columns H, D, V, of Chart V, are added, respectively, to the mean values of the forces for Washington and Toronto, i. e., H = 0.18250; D = 175.0; V = 0.58400.

In the case of V it was necessary to multiply the residuals for Washington by 2 and those for Toronto by $\frac{1}{2}$ in order to reduce them to about the same amplitude, as the sensitiveness of the instruments of these two stations was very different during December, 1895.